

APPENDIX A

Exposure Parameters Used in Developing Risk-Based Screening Levels

TABLE A-1

**EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING
LEVELS FOR PCBs FOR OUTDOOR COMMERCIAL/INDUSTRIAL WORKERS**

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
GENERAL EXPOSURE PARAMETERS		
Exposure Frequency (EF)	days/year	Value: 250 Rationale: DTSC, 2005
Exposure Duration (ED)	years	Value: 25 Rationale: DTSC, 2005
Body Weight (BW)	kg	Value: 70 Rationale: DTSC, 2005
Averaging Time (AT)	days	Value: 25,550 (carcinogens) 9,125 (noncarcinogens) Rationale: DTSC, 2005
PATHWAY-SPECIFIC PARAMETERS		
Incidental Soil Ingestion		
Soil Ingestion Rate (IR _s)	mg/day	Value: 100 Rationale: DTSC, 2005
Dermal Contact with Soil		
Exposed Skin Surface Area (SA _s)	cm ² /day	Value: 5,700 Rationale: DTSC, 2005; assumes head, hands, forearms, and lower legs are exposed
Soil-to-Skin Adherence Factor (SAF)	mg/cm ²	Value: 0.2 Rationale: DTSC, 2005
Absorption Fraction (ABS)	unitless	Value: 0.15 Rationale: DTSC, 2005; chemical-specific value

TABLE A-1

**EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING
LEVELS FOR PCBs FOR OUTDOOR COMMERCIAL/INDUSTRIAL WORKERS**

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
Inhalation of Suspended Soil Particulates		
Inhalation Rate (IHR _a)	m ³ /day	Value: 14 Rationale: DTSC, 2005; for an 8-hour workday
Particulate Emission Factor (PEF)	m ³ /kg	Value: 1.316x10 ⁹ Rationale: DTSC, 2005

Abbreviations:

cm²/day = centimeters squared per day

kg = kilograms

m³/day = cubic meters per day

m³/kg = cubic meters per kilogram

mg/cm² = milligrams per squared centimeters

mg/day = milligrams per day

References:

Department of Toxic Substances Control (DTSC), 2005, Recommended DTSC Default Exposure Factors for Use In Risk Assessment at California Military Facilities, Human and Ecological Risk Division (HERD), HERD HHRA Note Number 1, October 27.

TABLE A-2
EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING
LEVELS FOR PCBs FOR CONSTRUCTION WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
GENERAL EXPOSURE PARAMETERS		
Exposure Frequency (EF)	days/year	Value: 250 Rationale: DTSC, 2005
Exposure Duration (ED)	years	Value: 1 Rationale: DTSC, 2005
Body Weight (BW)	kg	Value: 70 Rationale: DTSC, 2005
Averaging Time (AT)	days	Value: 25,550 (carcinogens) 365 (noncarcinogens) Rationale: DTSC, 2005
Pathway-Specific Parameters		
Incidental Soil Ingestion		
Soil Ingestion Rate (IR _s)	mg/day	Value: 330 Rationale: DTSC, 2005
Dermal Contact with Soil		
Exposed Skin Surface Area (SA _s)	cm ²	Value: 5,700 Rationale: DTSC, 2005; assumes head, hands, forearms, and lower legs are exposed
Soil-to-Skin Adherence Factor (SAF)	mg/cm ²	Value: 0.8 Rationale: DTSC, 2005
Absorption Fraction (ABS _d s)	unitless	Value: 0.15 Rationale: DTSC, 2005; chemical-specific value

TABLE A-2
EXPOSURE PARAMETERS USED IN DEVELOPING RISK-BASED SCREENING
LEVELS FOR PCBs FOR CONSTRUCTION WORKERS

Former Pechiney Cast Plate, Inc., Facility
Vernon, California

Exposure Parameter	Units	Reasonable Maximum Exposure
Inhalation of Suspended Soil Particulates		
Inhalation Rate (IHR _a)	m ³ /day	Value: 20 Rationale: DTSC, 2005; for an 8-hour workday
Particulate Emission Factor (PEF)	m ³ /kg	Value: 1.0x10 ⁶ Rationale: DTSC, 2005

Abbreviations:

cm²/day = centimeters squared per day

kg = kilograms

m³/day = cubic meters per day

m³/kg = cubic meters per kilogram

mg/cm² = milligrams per squared centimeters

mg/day = milligrams per day

References:

Department of Toxic Substances Control (DTSC), 2005, Recommended DTSC Default Exposure Factors for Use In Risk Assessment at California Military Facilities, Human and Ecological Risk Division (HERD), HERD HHRA Note Number 1, October 27.

APPENDIX B

Toxicity Criteria Used in Developing Risk-Based Screening Levels

APPENDIX B-1
CARCINOGENIC TOXICITY CRITERIA USED IN DEVELOPING RISK-BASED SCREENING LEVELS
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Oral							Inhalation							
		Oral Cancer Slope Factor (CSFo) (mg/kg-day) ⁻¹	Target Species	Target Organ	Critical Effect	Reference	Weight-of-evidence	Reference	Unit Risk Factor (URF) (µg/m ³) ⁻¹	Inhalation Cancer Slope Factor (SFi) (mg/kg-day) ⁻¹	Target Species	Target Organ	Critical Effect	Reference	Weight-of-evidence	Reference
11141165	Aroclor-1232	2	Rat	Liver	Adenomas, carcinomas, cholangiomas	IRIS ¹	B2	IRIS	5.7E-04	2.0E+00	Rat	Liver	Tumors	OEHHA	B2	IRIS
12672296	Aroclor-1248	2	Rat	Liver	Adenomas, carcinomas, cholangiomas	IRIS ¹	B2	IRIS	5.7E-04	2.0E+00	Rat	Liver	Tumors	OEHHA	B2	IRIS
11097691	Aroclor-1254	2	Rat	Liver	Adenomas, carcinomas, cholangiomas	IRIS ¹	B2	IRIS	5.7E-04	2.0E+00	Rat	Liver	Tumors	OEHHA	B2	IRIS
11096825	Aroclor-1260	2	Rat	Liver	Adenomas, carcinomas, cholangiomas	IRIS ¹	B2	IRIS	5.7E-04	2.0E+00	Rat	Liver	Tumors	OEHHA	B2	IRIS

Notes:

- CSFo's obtained from IRIS instead of OEHHA Toxicity Criteria Database as the number presented in the Toxicity Criteria Database, 5 (mg/kg-day)⁻¹ (OEHHA, 2009a), is no longer considered appropriate for PCBs (OEHHA, 2005).
 - OEHHA, 2005, E-mail Correspondence Concerning PCB Oral Cancer Slope Factor, Between David M. Siegel, Ph.D., Chief, Integrated Risk Assessment Branch, and Robert Cheung, Geomatrix Consultants, August 26.
 - OEHHA, 2009a, Toxicity Criteria Database, California Environmental Protection Agency, on-line database <<http://www.oehha.ca.gov/risk/chemicaldata/index.asp>>.

References:

IRIS = U.S. EPA, 2009, Integrated Risk Information System (IRIS) database, <<http://www.epa.gov/IRIS/subst/index.html>>.
OEHHA = Office of Environmental Health Hazard Assessment, 2009, Toxicity Criteria Database, California Environmental Protection Agency, on-line database <<http://www.oehha.ca.gov/risk/chemicaldata/index.asp>>.

Weight of Evidence:

A = Known human carcinogen
2A or B1 = Probable human carcinogen - based on limited evidence of carcinogenicity in humans
2B or B2 = Likely to be carcinogenic to humans based on strong evidence of carcinogenicity in animals and inconclusive evidence of carcinogenicity in an exposed human population.
C = Possible human carcinogen
D = Inadequate evidence to assess carcinogenic potential

Abbreviations:

mg/kg-day = milligrams per kilogram per day
µg/m³ = micrograms per cubic meter

APPENDIX B-2
CHRONIC NONCARCINOGENIC TOXICITY CRITERIA USED IN DEVELOPING RISK-BASED SCREENING LEVELS
Former Pechiney Cast Plate, Inc., Facility
Vernon, California

CAS No.	Chemical	Oral						Inhalation						
		Oral Reference Dose (RfDo) (mg/kg-day)	UF x MF	Target Species	Target Organ	Critical Effect	Reference	Reference Concentration (RfC) (µg/m ³)	Inhalation Reference Dose (RfDi) (mg/kg-day)	UF x MF	Target Species	Target Organ	Critical Effect	Reference
11141165	Aroclor-1232	NA	--	--	--	--	NA	NA	NA	--	--	--	--	NA
12672296	Aroclor-1248	NA	--	--	--	--	NA	NA	NA	--	--	--	--	NA
11097691	Aroclor-1254	0.00002	300 x 1	Monkey	Immune system, Eyes	various	IRIS	0.07	0.00002	--	--	--	--	OEHHA (Route)
11096825	Aroclor-1260	NA	--	--	--	--	NA	NA	NA	--	--	--	--	NA

References:

IRIS = U.S. EPA, 2009, Integrated Risk Information System (IRIS) Database

OEHHA (Route) = RfDi extrapolated from RfDo in IRIS database as recommended by OEHHA (2009b)

- OEHHA, 2009b, E-mail Correspondence Concerning Route-to-Route Extrapolation, Between James C. Carlisle, DVM, OEHHA, and Caryn Kelly, AMEC Geomatrix Inc., March 17.

Abbreviations:

mg/kg-day = milligrams per kilogram per day

µg/m³ = micrograms per cubic meter

UF = Uncertainty Factor

MF = Modifying Factor

APPENDIX C

Site-Specific Modeling for the Protection of Groundwater

Appendix C

Site-Specific Modeling for the Protection of Groundwater

1.0 INTRODUCTION

PCBs in soil and concrete were evaluated for potential impacts to groundwater through the use of numerical modeling. Numerical simulations were performed to simulate the fate and transport of PCBs in a one-dimensional soil column in the vadose zone. The modeling was performed using commercial software, MODFLOW-SURFACT (HydroGeologic, Inc., 2006).¹ The code for this software is based on the most commonly used groundwater modeling software, MODFLOW (Harbaugh et al., 2000),² released by the United States Geological Survey. The MODFLOW-SURFACT code has an additional capability to simulate the moisture migration as well as the fate and transport of chemicals in vadose zone using the Van Genuchten's model.

MODFLOW-SURFACT is similar to the one-dimensional vadose zone transport model, VLEACH (Ravi and Johnson, 1994).³ This code was selected because it is supported by a commonly used MODFLOW pre- and post-processing graphical user interface software, Groundwater Vista®, which was released by Environmental Simulation, Inc. (2007).⁴

2.0 MODEL CONSTRUCTION AND PARAMETERS

A one-dimensional MODFLOW-SURFACT model was constructed to simulate a one-dimensional soil column. The model domain consisted of one row and one column. Vertically, the model has thirty layers with a uniform thickness of 5 feet to represent the vadose zone and one layer with a thickness of 50 feet to represent the saturated zone. The groundwater table was assumed to be at 150 feet below ground surface (bgs).

¹ HydroGeologic, Inc., 2006, MODFLOW-SURFACT (version 3.0), Reston, Virginia, May

² Harbaugh, A.W., E.R. Banta, M.C. Hill, and M.G. McDonald, 2000, MODFLOW-2000, The U.S. Geological Survey Modular Ground-water Model – User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, p. 121

³ Ravi, V. and J.A. Johnson, 1994, VLEACH (version 2.1), Center for Subsurface Modeling Support, Robert Kerr Environmental Research Laboratory, Ada, Oklahoma.

⁴ Environmental Simulation, Inc., 2007, Groundwater Vista (version 5.01), Reinholds, Pennsylvania, June.

The lithologic profile used in the MODFLOW-SURFACT model was based on the logs of on-site Borings 125 and 126; the lithologic profile developed from these two borings was considered representative of site-wide conditions. The hydrogeologic parameters and Van Genuchten's model parameters for each layer were obtained using the computer code ROSETTA (version 1.2) developed by the Salinity Laboratory of the United States Department of Agriculture (2000).⁵ The inputs to the ROSETTA code are the percentage of sand, silt, and clay in each layer. For each boring, the percentages of gravel, sand, silt, and clay in 5-foot intervals between the ground surface and the groundwater table were estimated. The percentage of gravel is combined with the percentage of sand as the ROSETTA does not take percentage of gravel as an input. The percentages in the same interval for the two borings were then averaged to obtain average percentages as input to ROSETTA. In the MODFLOW-SURFACT model for crushed concrete, the hydrogeologic parameters and Van Genuchten's model parameters for 100% sand were used for the top 15 feet of vadose soil to represent the crushed concrete as fill.

The other model parameters are listed below.

- Soil bulk density, $\rho = 96$ pounds per cubic feet
- Porosity, $n = 0.40$
- Soil organic carbon content, $f_{oc} = 0.39\%$
- Sorption partition coefficient for PCBs, $K_{oc} = 309,000$ liters per kilogram

Site-specific soil physical properties were based on the field investigations of the Morrison Knudsen Corporation (1995).⁶ The effective porosity value in the model is assumed to be 40 percent, based on an average porosity value of 47 percent. The sorption partition coefficient for PCBs was obtained from U.S. EPA guidance (1996).⁷ The dispersivity in the model is assumed to be equal to 15 feet, 10 percent of the simulated distance between PCB source and groundwater table (150 feet).

Infiltration was applied to the uppermost model layer. An average infiltration rate of 4 inches per year was assumed. The 4 inches per year infiltration rate is approximately equal to 25 percent of the average precipitation in the site area, and is

⁵ United States Salinity Laboratory, 2000, ROSETTA (version 2.1), Agricultural Research Service, United States Department of Agriculture, November

⁶ Morrison Knudsen Corporation, 1995, Final Report Stoddard Solvent System Field Investigation, Aluminum Company of America, October 27.

⁷ U.S. EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document, Office of Solid Waste and Emergency Response, Washington, D.C., EPA/540/R-95/128, May.

considered conservative for a largely paved or vegetated land surface. The average total annual precipitation at a weather station near the city of Vernon from 1914 to 2007 is 14.8 inches per year.⁸ As a reference, if the infiltration rate is calculated using the recharge model of Williamson et al., 1989,⁹

$$R = \max[(0.64 \times P - 9.1), 0]$$

where, R = infiltration rate (inches/year)

P = precipitation (inches/year)

the infiltration rate is approximately 0.4 inches per year. A study on infiltration rates in the Riverside County, which has similar meteorological condition as the site, by USGS also suggested that the land surface infiltration rate is much less than 25% of precipitation.¹⁰ Therefore, the infiltration rate of 4 inches per year is a conservative assumption, even for an unpaved land surface. A constant head boundary with the specified head equal to the elevation of the top of the bottom layer was applied at the bottom layer to represent the groundwater table elevation in the saturated zone.

The model is run in transient mode for a period of 500 years. There are 50 stress periods, each of which is 10 year long and divided into 120 monthly time steps.

3.0 SIMULATIONS

Two separate simulations, one for PCBs in soil and another for PCBs in concrete (assumed to be crushed and re-used as fill on-site), were conducted to determine if the detected concentrations in either medium pose a threat to groundwater quality. Specifically, the simulations were used to estimate site-specific attenuation factors for PCBs, which were then used in reverse calculations from the groundwater maximum contaminant level (MCL) to determine the concentrations that would be necessary in the vadose zone to pose a potential threat to groundwater.

⁸ Western Regional Climate Center, <http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca5115>

⁹ Williamson, A.K., D.E. Prudic, and L.A. Swain, 1989, Ground-water flow in the Central Valley, California, U.S. Geological Survey Professional Paper 1401-D.

¹⁰ USGS, Rainfall-Runoff Characteristics and Effects of Increased Urban Density on Streamflow and Infiltration in Eastern Part of the San Jacinto River Basin, Riverside County, California, USGS Water-Resources Investigations Report 02-4090.

3.1 PCBs in Soil

The MODFLOW-SURFACT model described above was used to estimate site-specific attenuation factors for PCBs in soil at hypothetical source depths of 15 feet, 30 feet, and 45 feet bgs. These attenuation factors were estimated by having the MODFLOW-SURFACT model simulate the movement of PCBs in pore water from these depths to pore water immediately above the water table (at approximately 150 feet bgs) after 500 years. A constant PCB concentration in pore water of 100 micrograms per liter ($\mu\text{g/L}$) was assumed at each source depth for the simulations. The attenuation factors were then calculated as the ratios of the source pore water concentration (100 $\mu\text{g/L}$) to the simulated pore water concentrations immediately above the water table. All calculations using the MODFLOW-SURFACT simulation results were implemented in Mathcad® (version 14; Parametric Technology Corporation, 2007) (Worksheet C-1).

For the hypothetical source depths of 15 and 30 feet bgs, the simulated pore water concentrations immediately above the water table were below the lowest value that the MODFLOW-SURFACT could report (1×10^{-44} $\mu\text{g/L}$). The minimum reportable concentration (1×10^{-44} $\mu\text{g/L}$) was therefore used as the simulated pore water concentration immediately above the water table in calculating the attenuation factors for these two cases. As the pore water concentrations immediately above the water table would actually be lower than this minimum reportable value, the simulated attenuation is actually higher than the results would indicate.

As presented in Worksheet C-1, the attenuation factors calculated with this method ranged from 2.2×10^{44} to 1×10^{46} for source depths of 15 to 45 feet bgs. These attenuation factors are conservative because the dilution of PCBs after entering the saturated zone and the degradation of PCBs in the vadose zone are not considered in the MODFLOW-SURFACT model. These attenuation factors were then used in a reverse calculation from the MCL, 0.5 $\mu\text{g/L}$, to estimate the source pore water concentrations at 15 feet, 30 feet, and 45 feet bgs that would be necessary to pose a potential threat to groundwater quality. The estimated source pore water concentrations ranged from 1.1×10^{41} to 5×10^{42} milligrams per liter (mg/L) (Worksheet C-1). Based on these calculations, the concentration of PCBs in source pore water at the Site would need to exceed 1.1×10^{41} mg/L at 45 feet bgs or 5×10^{42} mg/L at 15 to 30 feet bgs to result in groundwater concentrations exceeding the MCL. Because these concentrations greatly exceed the solubility limit of PCBs in water (0.7 mg/L ;

U.S. EPA, 1996)¹¹ and exceeds the concentration of pure phase PCBs (1×10^6 mg/L), it is physically impossible to achieve PCB concentrations in the source pore water that would result in a concentration of PCBs exceeding the MCL in groundwater.

Therefore, PCBs in soil at the Site do not pose a potential threat to groundwater at the Site.

3.2 PCBs IN CRUSHED CONCRETE

Because crushed concrete containing PCBs may be re-used as on-site fill materials within the upper 15 feet of the vadose zone, the reverse calculation method described above was also used to verify that PCBs in re-used crushed concrete do not pose a potential threat to groundwater quality. The MODFLOW-SURFACT simulation was performed in the same manner as described above for soil, but modified to account for the physical properties associated with crushed concrete. For crushed concrete, sand (approximating the properties for crushed concrete) was used for the hydrogeologic parameters and Van Genuchten's model parameters rather than the lithologic parameters estimated for the upper 15 feet of the soil column. An attenuation factor was then estimated for PCBs from a source depth of 15 feet bgs, corresponding to the bottom depth of proposed concrete re-use. As presented in Worksheet C-2, the attenuation factor estimated for the concrete re-use scenario was 1×10^{46} , equal to the attenuation factor estimated for PCBs in native soil at 15 or 30 feet bgs (Worksheet C-1). Correspondingly, the source pore water concentration of PCBs dissolved from crushed concrete at 15 feet bgs would need to exceed 5×10^{42} mg/L to result in groundwater concentrations exceeding the MCL. As noted earlier for soil, these concentrations greatly exceed the solubility limit of PCBs in water (0.7 mg/L; U.S. EPA, 1996) and exceed the concentration of pure phase PCBs (1×10^6 mg/L), and therefore it is physically impossible to achieve PCB concentrations in the source pore water from the crushed concrete that would result in a concentration of PCBs exceeding the MCL in groundwater. Therefore, PCBs in concrete that may be re-used as on-site fill materials also do not pose a potential threat to groundwater at the Site.

¹¹ U.S. EPA, 1996, Soil Screening Guidance: Users Guide and Technical Background Document, Office of Solid Waste and Emergency Response, Washington, D.C., EPA/540/R-95/128, May.

Worksheet C-1

Site-specific Modeling for the Protection of

Groundwater – PCBs in Soil

Project Number 010627.003.0

Calculated by: Miao Zhang
Date: June 25, 2009

Define Unit: $\mu\text{g} := 10^{-6} \text{ gm}$

Given Parameters:

PCB Solubility in Water $S_w := 0.7 \frac{\text{mg}}{\text{L}}$

Reference: U.S.EPA Soil Screening Guidance: User's Guide, 2nd Edition, July 1996

Maximum Contaminant Level for PCBs $\text{MCL} := 0.5 \cdot \frac{\mu\text{g}}{\text{L}}$

Calculations:

1. Source at 15 ft bgs

Assumed concentration in pore water at source
in MODFLOW-SURFACT simulation:

$$C_{ps} := 100 \frac{\mu\text{g}}{\text{L}}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years is below the smallest value that the mode can report (1×10^{-44}). Therefore, 1×10^{-44} is used as a conservative estimate of the simulated pore water concentration in layer 30.

$$C_{ws} := 1 \cdot 10^{-44} \frac{\mu\text{g}}{\text{L}}$$

Attenuation factor (i.e. ratio of pore water
concentration at source to pore water
concentration in layer 30)

$$\text{AF} := \frac{C_{ps}}{C_{ws}} \quad \text{AF} = 1 \times 10^{46}$$

Concentration in pore water at source that
corresponds to a pore water concentration
immediately above the water table equal to
the MCL

$$C_i := \text{MCL} \cdot \text{AF} \quad C_i = 5 \times 10^{42} \cdot \frac{\text{mg}}{\text{L}}$$

$$C_i \gg S_w$$

2. Source at 30 ft bgs

Assumed concentration in pore water at source
in MODFLOW-SURFACT simulation:

$$C_{ps} := 100 \frac{\mu\text{g}}{\text{L}}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years is below the smallest value that the mode can report (1×10^{-44}). Therefore, 1×10^{-44} is used as a conservative estimate of the simulated pore water concentration in layer 30.

$$C_{ws} := 1 \cdot 10^{-44} \frac{\mu\text{g}}{\text{L}}$$

Attenuation factor (i.e. ratio of pore water
concentration at source to pore water
concentration in layer 30)

$$AF := \frac{C_{ps}}{C_{ws}} \quad AF = 1 \times 10^{46}$$

Concentration in pore water at source that
corresponds to a pore water concentration
immediately above the water table equal to
the MCL

$$C_i := MCL \cdot AF \quad C_i = 5 \times 10^{42} \frac{\text{mg}}{\text{L}}$$

$$C_i \gg S_w$$

3. Source at 45 ft bgs

Assumed concentration in pore water at source
in MODFLOW-SURFACT simulation:

$$C_{ps} := 100 \frac{\mu\text{g}}{\text{L}}$$

MODFLOW-SURFACT simulated pore water
concentration in layer 30 (just above groundwater
table) after 500 years

$$C_{ws} := 4.64 \cdot 10^{-43} \frac{\mu\text{g}}{\text{L}}$$

Attenuation factor (i.e. ratio of pore water
concentration at source to pore water
concentration in layer 30)

$$AF := \frac{C_{ps}}{C_{ws}} \quad AF = 2.155 \times 10^{44}$$

Concentration in pore water at source that
corresponds to a pore water concentration
immediately above the water table equal to
the MCL

$$C_i := MCL \cdot AF \quad C_i = 1.078 \times 10^{41} \frac{\text{mg}}{\text{L}}$$

$$C_i \gg S_w$$

Worksheet C-2

Site-specific Modeling for the Protection of

Groundwater - PCBs in Crushed Concrete

Project Number 010627.003.0

Calculated by: Miao Zhang

Date: June 25, 2009

Define Unit:

$$\mu\text{g} := 10^{-6} \text{ gm}$$

Given Parameters:

PCB Solubility in Water

$$S_w := 0.7 \frac{\text{mg}}{\text{L}}$$

Reference: U.S.EPA Soil Screening Guidance: User's Guide, 2nd Edition, July 1996

Maximum Contaminant Level for PCBs

$$\text{MCL} := 0.5 \cdot \frac{\mu\text{g}}{\text{L}}$$

Calculations:

Source (crushed concrete) at 15 ft bgs

Assumed concentration in pore water at source
in MODFLOW-SURFACT simulation:

$$\text{Cps} := 100 \frac{\mu\text{g}}{\text{L}}$$

MODFLOW-SURFACT simulated pore water concentration in layer 30 (just above groundwater table) after 500 years is below the smallest value that the model can report (1×10^{-44}). Therefore, 1×10^{-44} is used as a conservative estimate of the simulated pore water concentration in layer 30.

$$\text{Cws} := 1 \cdot 10^{-44} \frac{\mu\text{g}}{\text{L}}$$

Attenuation factor (i.e. ratio of pore water
concentration at source to pore water
concentration in layer 30)

$$\text{AF} := \frac{\text{Cps}}{\text{Cws}}$$

$$\text{AF} = 1 \times 10^{46}$$

Concentration in pore water at source that
corresponds to a pore water concentration
immediately above the water table equal to
the MCL

$$\text{Ci} := \text{MCL} \cdot \text{AF} \quad \text{Ci} = 5 \times 10^{42} \cdot \frac{\text{mg}}{\text{L}}$$

$$\text{Ci} \gg \text{Sw}$$